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TITLE OF THE INVENTION

Method and Apparatus for Processing and
Re-Using of Gray Water for Flushing Toilets

PRIORITY CLAIM

- 5 This application is based on and claims the priority under 35 U.S.C. §119 of German Patent Application 102 29 799.1, filed on July 3, 2002, the entire disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

- 10 The invention relates to a method and apparatus for processing and re-using of gray water for the flushing of toilets, particularly in vacuum toilet systems used in aircraft to optimize the use of available water.

BACKGROUND INFORMATION

- 15 Commercial aircraft current carry fresh water for the flushing of vacuum operated toilets in these aircraft. Moreover, the lavatory basins also use freshwater which, by its use in the handwash basin becomes so called "gray water". Thus, in the

passenger toilets substantial quantities or volumes of gray water are produced, which conventionally are not used for any further purpose. The inventors have discovered that following a simple treatment or processing of this gray water it would be quite suitable for use as toilet flushing water.

OBJECTS OF THE INVENTION

In view of the foregoing it is the aim of the invention to achieve the following objects singly or in combination:

to provide a method and apparatus that will enable the use of gray water produced in an aircraft or other conveyance particularly in lavatory basins and other use locations such as bathtubs and showers on a ship that do not produce black water; and

to reduce the amount of fresh water that an aircraft conventionally had to carry to avoid the use of disinfectants in the treatment of the gray water.

SUMMARY OF THE INVENTION

According to the invention there is provided a method for processing and reusing gray water for flushing a toilet, comprising the following steps:

- a) filtering said gray water to provide filtered water,
- b) collecting said filtered water in a processing tank,

- c) anodically oxidizing said filtered water in said processing tank to provide processed water, and
- d) using said processed water for flushing a toilet bowl in a lavatory or toilet.

5 According to the invention there is further provided an apparatus for processing and reusing gray water, said apparatus comprising:

- a) at least one filter having a filter inlet connected to a source of said gray water and a filter outlet,
- b) a processing tank having an inlet connected to said filter outlet,
- c) means for anodically oxidizing filtered water in said processing tank to provide processed, oxidized water, and
- d) a pump connected with a pump inlet to said processing tank, an excess pressure valve connected to an outlet of said pump, at least one rinsing spray nozzle installed in a toilet bowl and connected to said excess pressure valve for rinsing said toilet bowl in response to a generated control signal for a predetermined time interval at the end of which said pump is automatically switched off and said excess pressure valve is closed again. The pump may be any pump that generates a sufficient water pressure to open the excess pressure valve. A rotary or piston cylinder pump is suitable.

• BRIEF DESCRIPTION OF THE DRAWING

The accompanying single Figure shows a block diagram of an apparatus for performing the present method.

5 DETAILED DESCRIPTION OF A PREFERRED EXAMPLE EMBODIMENT AND OF THE BEST MODE OF THE INVENTION

The block diagram of Fig. 1 shows the important components that are installed, for example in a toilet of a commercial passenger aircraft. The components include an apparatus for treating and reusing gray water for the flushing of a toilet. A faucet 1 is
10 installed for supplying fresh water into a lavatory basin 2. The faucet receives fresh water from a source 18 through a fresh water conduit 18A. The faucet 1 is controllable either manually or automatically by a faucet control 1A. A heater 1B provides hot water to the faucet. The faucet discharges fresh water
15 through an outlet 1C into the lavatory basin 2. An easily exchangeable coarse filter 3 is installed in the outlet of the basin 2 to feed coarsely filtered gray water through a further fine filter 4 that is also easily cleaned or exchanged. The fine filter is preferably installed in a gray water treatment chamber
20 5 so that the fine filter 4 is externally accessible for maintenance. Contaminations and any coloring agents are removed from the gray water and remain in the fine filter 4.

The gray water after passing through the coarse filter 3 and the fine filter 4 is collected in the processing tank 5 for a further

treatment by an anodic oxidizer 9 controlled by a central control unit 7.

The treatment chamber 5 in which the gray water is collected, is equipped with an overflow 6 that leads into a gray water collecting conduit 19. The excess gray water taken up by the overflow 6 is either used in a tank cleaning system for cleaning of a wastewater tank not shown, but including a collecting chamber, a pressure increasing pump and at least one spray nozzle. Alternatively, any excess processed water can be fed to a discharge or drainage mast for discharge outside the aircraft body.

The treatment container 5 is also equipped with preferably at least two water level sensors LIS21 and LIS22 which provide their sensor signals to the central processing unit 7 which processes the sensor signals to form control signals. If the water content, or rather the treated water content in the treatment tank 5 reaches the low level sensed by the sensor LIS22, the respective signal is processed to provide a control signal for the controller 1A of the faucet 1 to thereby replenish the water in the treatment tank 5 with fresh water. This replenishing takes place automatically through the lavatory basin 2 and is preferably performed when the respective toilet is unoccupied. For this purpose a toilet door switch 15 and an infrared sensor 16 are used to provide their respective signals to the central processing unit 7, which in turn provides a control signal through an electrical connection 1D to the faucet 1. The

automatic replenishing is disabled when the toilet is occupied so as not to startle a user when the faucet would open automatically. The replenishing is stopped when the water level in the tank 5 reaches the position of the upper or maximum level sensor LIS21.

The flushing of a toilet bowl 11 is initiated by a rinsing button 14 that also delivers its signal to the central processing unit 7 for starting a motor M that drives a pump 8 for increasing the pressure of the water coming from the tank 5 through a conduit 8A. The pressure is increased until an excess pressure valve 13, operable by the central control unit 7 through a solenoid 13A, opens, to supply flushing water through the nozzles 12 into the toilet bowl 11 for rinsing the toilet bowl. The control unit 7 provides a time interval following the operation of the button 14. At the end of this time interval the motor M is switched off again. Simultaneously, the central control unit 7 energizes a vacuum toilet flushing system 10 also for a defined time interval, whereby any blackwater containing feces or the like is sucked into the vacuum wastewater system 20 which is equipped with a separate wastewater conduit 20A. According to the invention the fresh water supply conduit 18A, the gray water collecting conduit 19 and the wastewater conduit 20A are entirely separate from each other. In other words, there is no direct connection between these conduits 18A, 19 and 20A.

The control, closed loop control, and monitoring of the above described replenishing operation, pumping operation, and flushing

operation and the power supply to the pump, valves and vacuum flushing system 10 is performed by the central control unit 7 which in turn communicates with other system components in the aircraft through a so-called CANBUS, also referred to as communication area network.

Instead of using a rotary pump the pump 8 could be a piston cylinder pump not shown. In such a pump a sensor would monitor the end position of the piston in the cylinder to provide a control signal through the control unit 7 to drive the piston back into a starting position thereby sucking a dosed volume of treated water into the cylinder for the next toilet flushing.

Advantages of the invention are seen in that the use of fresh water is noticeably reduced, whereby it is now possible to use smaller freshwater tanks in an aircraft, thereby reducing the required fresh water volume with the added benefit of reducing the starting weight of the aircraft, which in turn positively influences the payload or the fuel consumption.

Yet another advantage is seen in that the anodic oxidizing of the gray water as taught by the invention obviates the use of a so-called recharge liquid which is a disinfectant that is mixed into the gray water or wastewater so that the wastewater tank does not require a separate disinfection. Again, obviating the need for a disinfection agent reduces the starting weight of the aircraft with the same positive effects regarding the payload and the fuel consumption as mentioned above.

Another advantage is seen that by not using the so-called disinfecting agent no water is produced that requires a special handling of the respective wastewater on the ground when servicing an aircraft which is conventionally rather expensive.

5 By using the anodically oxidized gray water as taught by the invention as a toilet rinsing water, the resulting wastewater can be discharged directly into sewage treatment plants on the ground. Furthermore, the anodically oxidized rinsing water acts as a preventive agent against the formation of a so-called
10 biofilm in toilets and respective wastewater conduits.

A further advantage is seen in that the present system can work with noticeably higher rinsing pressures as is conventionally possible, which has a positive influence since less water can be used for the toilet flushing, while even better cleaning results
15 are achieved.

The control of all toilet facilities and their respective components takes place by a single control unit 7. The connection to other aircraft systems is possible through the above mentioned simple so-called CANBUS which is available in the
20 aircraft anyway and thus no further efforts and expenses are necessary for an individual wiring system.

Although the invention has been described with reference to specific example embodiments, it will be appreciated that it is intended to cover all modifications and equivalents within the
25 scope of the appended claims. It should also be understood that the present disclosure includes all possible combinations of any individual features recited in any of the appended claims.